Abstract

The work presented in this dissertation describes the vibration, buckling and dynamic instability behaviour of stiffened shell panels (isotropic and laminated composite) with/without cutouts under uniform and various non-uniform in-plane edge loadings.

The eight-noded isoparametric degenerated shell element and a compatible three-noded curved beam element are used to model the shell panels and the stiffeners respectively. As the usual formulation of degenerated beam element is found to overestimate the torsional rigidity, an attempt has been made to reformulate it in an efficient manner. Moreover the new formulation for the beam element requires five degrees of freedom per node as that of shell element. In the present investigation the analysis for free vibration, buckling(static stability) and dynamic stability of the isotropic and laminated composite stiffened shell panels with and/or without cutout are implemented by a computer program written in Fortran-90. The elastic stiffness, mass and geometric stiffness matrices of the elements are derived with the help of suitable interpolation functions (shape functions) within the element and integrating various expressions over the element volume by Gauss quadrature numerical technique. As the stress field is non-uniform, due to arbitrary nature of applied in-plane load, boundary conditions, stiffeners, and cutout in the structure, pre-buckling stress analysis is carried out using finite element method to determine the stresses. These stresses at the Gauss points are used to formulate the geometric stiffness matrix. The elastic stiffness, mass and geometric stiffness matrices are computed for all the shell elements and stiffener elements of the entire structure. The elemental matrices are assembled together to form the corresponding global matrices. The skyline storage algorithm is used to keep big size matrices in single array.

Qualitative results are presented to show the effects of geometry of shell panels, aspect ratio, lamination scheme, stiffening scheme, static and dynamic load factors, non-uniform loading type, load band width, ply stacking scheme in the stiffener and boundary condition on the stability boundary. The effects of cutout on vibration, buckling and

instability regions are also presented. All the parameters are seen to have significant effects on the stability behaviour of the isotropic and laminated composite stiffened shell panels.

Thesis organization: The entire thesis is organized into **Six** chapters.

Chapter-1 includes the general introduction and importance of the present studies. The general method of solving static and dynamic stability of stiffened composite/isotropic shell panels with and without cutout has been briefly addressed in this chapter.

The review of related literature conforming to the scope of the study has been presented in **Chapter-2**. The various work done previously relating to stiffened plate and shells are briefly described in this chapter. The objective and scope of the present investigations are also presented here.

Chapter-3 presents the finite element formulation, the governing equations and the method of solution of the problem under consideration. The analysis is focused mainly on the determination of the primary instability region, which is important in practical use.

The brief descriptions of the problems taken for the analysis are presented in **Chapter-4**. The description about the geometry of the stiffened panels, loading type, boundary conditions and material properties are also included in this chapter.

The detailed results and discussion on vibration, static stability (buckling) and dynamic stability characteristics of the isotropic and laminated composite stiffened shell panels with and without cutout subjected to uniform and non-uniform in-plane loading along the edges are presented in **Chapter-5**. The results are compared with the experimental and analytical values wherever possible and the discrepancies, if any, have been discussed. A good number of new problems are solved and the results are discussed to study the effects

of various parameters on buckling, vibration and dynamic stability characteristics of isotropic and laminated composite stiffened shell panels with and without cutouts.

The important conclusions drawn from the theoretical findings in the present investigation are listed in **Chapter-6**. The possible scope of extension of the present study has been appended to the concluding remarks. A list of references cited in the text is given after the end of this chapter. The details about the solution techniques and description of the computer program are enclosed in the **Appendix**.

Key words: Dynamic stability, vibration, buckling, finite element method, laminate composite stiffened shells, degenerated shell element, curved beam element, non-uniform in-pane loading and cutouts.